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An R&D Agenda to Enhance Electricity System Reliability by Increasing Customer Participation in Emerging Competitive Markets

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INTRODUCTION

Recent electricity price spikes are painful reminders of the value that meaningful demand-side responses could bring to the restructuring US electricity system. Review of the aggregate offers made by suppliers confirms that even a modest increase demand elasticity could dramatically reduce these extremes in price volatility. We submit that dramatically increased customer participation in these markets to enhance system reliability and reduce price volatility is sorely needed. Indeed, allowing customers to manage their loads in response to system conditions might be thought of as the ultimate reliability resource.

Most would agree that meaningful demand-side responses to price are the hallmark of a well-functioning competitive market (Kirby and Kueck 1999). Yet, in today s markets for electricity, little or no such response is evident. In effect, today s markets are incomplete; they represent only half of what a truly competitive market requires.

The reason is simple: customers currently do not experience directly the time-varying costs of their consumption decisions. Consequently, they have no incentive to modify these decisions in ways that might enhance system reliability or improve the efficiency of the markets in which electricity is traded.

We submit that increased customer participation is a necessary step in the evolution toward more efficient markets for electricity and ancillary services. Toward this end, this paper outlines an agenda for public-interest R&D in support of this objective.

CUSTOMERS ARE NOT GENERATORS

The fundamental insight required to tap the potential for customer participation in competitive markets for electricity and ancillary services is the recognition that customers are not generators. Traditionally, the electric power system consisted of centrally dispatched, hierarchically controlled generating units that met all customer demands. While units were dispatched in merit order based roughly on the increasing marginal cost of production, operators endeavored to meet all demands no matter what it cost.

In a true market, customers have the option to select a level of service reliability based on their individual assessment of its cost and value. Realizing such a future calls for fundamental changes in the ways in which electricity generation and consumption decisions will be made.

First, generators will no longer be subject to complete control by central operating authorities. Instead, they will make decisions to operate based on market conditions. At the system level, operators concerns shift from issuing dispatch orders to, instead, measuring, tracking, and predicting generator performance in response to supplier offers. This fundamental shift in operators responsibilities applies equally to customers offering their loads into these markets. However, the number and size of customers that could potentially participate in these markets is orders of magnitude larger and smaller, respectively, compared to the number and size of generators participating in these markets.

Second, while generators may only modestly change their physical and operating characteristics under the new institutional and ownership structures brought forth by restructuring, customers offering their loads into these markets differ significantly from generators. Physically, customers will not be able to provide all of the system services traditionally provided by generators. Institutionally, and perhaps most important of all, most customers unlike generators will not view participation in electricity markets as their primary business activity.

TOWARD AN INTEGRATED RESEARCH AGENDA

Together, these two insights suggest that enabling customer participation in competitive electricity markets will require much more than simple changes in eligibility requirements. Instead, we submit that recognition of the fundamental differences between generators and customers calls for a multi-faceted research agenda that addresses both the institutional and technical issues underlying these differences. In the remainder of this summary, we outline some of the key elements for such an agenda.

Information Needs and Control Requirements of System Operators

The recognition that negawatts are not megawatts is most pronounced from the standpoint of electricity system operators. One cannot manage what one cannot measure and current systems for managing electric system reliability are predicated on large generators with measurable outputs. Modifying operational control systems to accommodate load reductions on an equivalent basis with electricity generation poses a series of challenges. First and foremost, the underlying system reliability rules and practices underlying current telemetry requirements and control procedures must be reviewed and redefined from a technology-neutral point of view, yet without compromise

to the management of system reliability (Kirby and Hirst 1999). Second, new communication and control technologies consistent with these re-definitions must be developed and implemented. For the most part, we do not envision new fundamental R&D in sensor, communication, and control technologies, but instead new forms of integrating existing technologies consistent with the management of customer s loads, as reliability resources.

Repositioning Existing Utility Load Management Assets

Utility load management programs, including direct load control, interruptible load, and real-time pricing, constitute a large installed base of controllable loads that in principle should be considered system reliability resources. The underlying communication, control, and metering technologies, as well as potentially the program designs and operational procedures, themselves, represent important, yet currently un-appraised (and potentially undervalued), assets for future competitive markets. In the short run, modified and improved operation of these programs may be the most effective form of demand-side response available to the electricity system today. Existing assets must be carefully scrutinized in light of recent technological advances and incremental investments considered. In the long run, continued utility operation of these programs must be evaluated in the light of regulatory questions regarding the scope of regulated and unregulated utility activities in future markets for retail energy services.

Accelerate the Transfer Emerging Program Experiences

Utilities and ISOs around the country are currently engaged in nascent efforts to develop programs that attempt to tap customer load management activities explicitly as a reliability resources (Siegel 2000). Maturation of these programs would be accelerated by greater sharing of program experiences among current and other potential program sponsors and market participants. For example, creation of competitive markets for the provision of retail energy services has led to entry by load aggregators that serve as market intermediaries between individual customers and system operators. By virtue of representing aggregations of customers, these entities can in principle internalize and spread the performance risk associated with reliance on individual loads and thereby guarantee minimum levels of performance to system operators. Similarly, by serving as a single point of contact for system operators they may also reduce system communication, control, and metering requirements (again, by internalizing them). Understanding the market niches served and overall business strategies employed by these new entrants is critical to ensuring uniform and fair market rules to guide their participation in the competitive electricity market place.

Pioneer Promising New Program Design Concepts

Real-time pricing is often mentioned as a necessary condition for enabling meaningful customer participation in competitive markets. And, indeed, developing second-generation real-time pricing programs consistent with the design and operation of current competitive electricity markets should be a high priority (Capage et al 1999). However, in addition, there are many other worthy program design concepts, such as priority service, that should also be explored. The basic observation is, as stated earlier, that customers are incredibly heterogeneous in their preferences. For example, some customers may prefer to view provision of their loads as system reliability resources simply as a new profit center. Still others may be willing to offer their loads only in response to true system emergencies. Many customers will require substantial advance notification, and will want to limit the duration and frequency of interruptions; others will be substantially more flexible. Enabling widespread customer participation will require substantial creativity. We should not be surprised to learn that (and therefore should foster the development of) a multiplicity of approaches is required to effectively target and extract the full potential load as a system reliability resource. Consumer market research, coupled with experimental economic approaches, is needed to quickly and inexpensively develop and test promising new approaches.

Incorporate Grid Reliability Considerations into the Design and Operation of End-Use Technologies

Today, few end-use technologies have been designed with any consideration for their impacts on grid reliability (Dagle, et al 1997). Many, such as induction motors and various power electronics devices, are in fact well-known for the special challenges they create for reliable grid operation. As grid reliability services become unbundled and traded in competitive markets, the true costs and value of these currently externalized impacts of end-use technologies will be revealed. As a result, an environment for the re-design of and new controls for the operation of end-use technologies will emerge. Still, there remain substantial institutional challenges in linking system reliability needs to manufacturer s end-use electricity product offerings. Some have suggested that government standards may be required to cement this linkage. Regardless of the specific institutional pathway, there is need for enabling research to improving our understanding of the grid reliability impacts of end-use devices, and to identify technical options to modify these impacts.

Disseminate Technology and Programmatic Solutions through Demonstrations

Research will only bear fruit when it is demonstrated and refined in real-world market and operating settings. An integrated program of research, therefore, must include as a necessary element R&D demonstrations that address the real-world situations faced by system operators and market participants today. Engagement with these stakeholders to identify the specific needs for and then to implement prototype solutions must remain the cornerstone of a successful R&D program.

SUMMARY

Tight markets for capacity, excessive price volatility, and increasingly frequent reliability events are all signs of an electricity system under stress. Unlocking the tremendous potential of customer s loads ought to be a core element of strategies to relieve these stresses. Indeed, we believe that enabling meaningful customer participation is a necessary ingredient for the ultimate realization of truly competitive and efficient markets for electricity. This paper has outlined needed research toward this end.

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